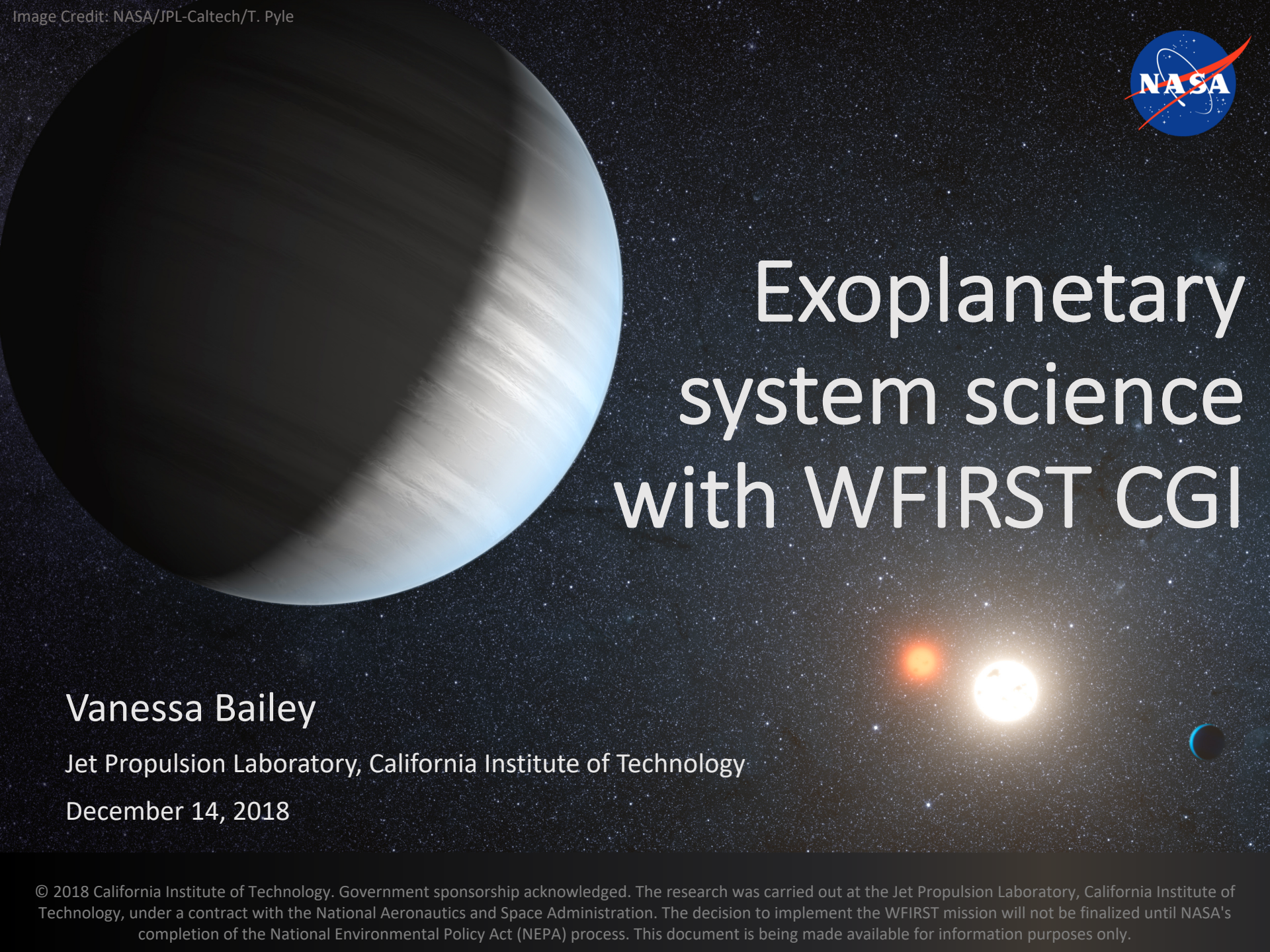


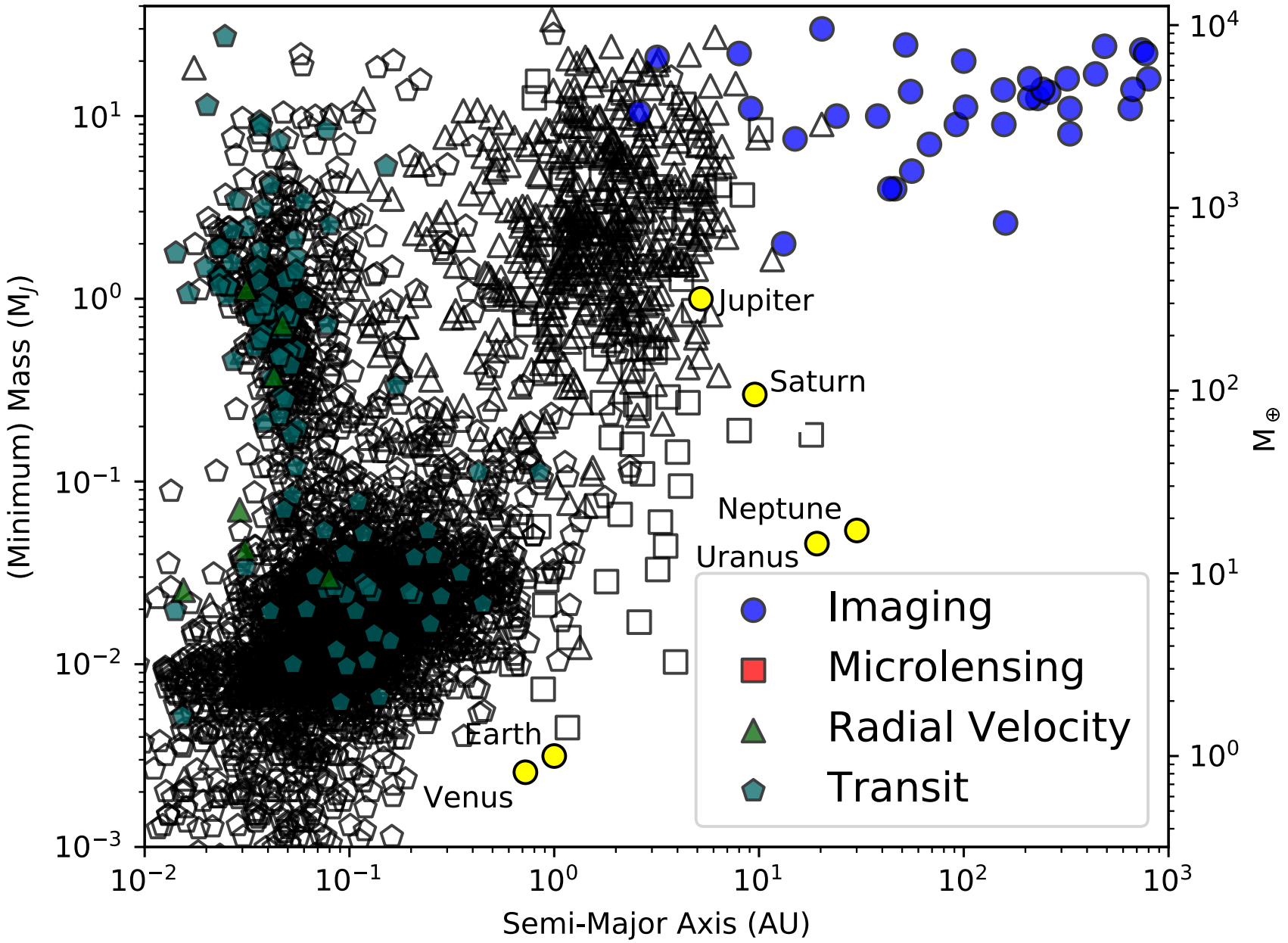
Exoplanetary system science with WFIRST CGI

Vanessa Bailey

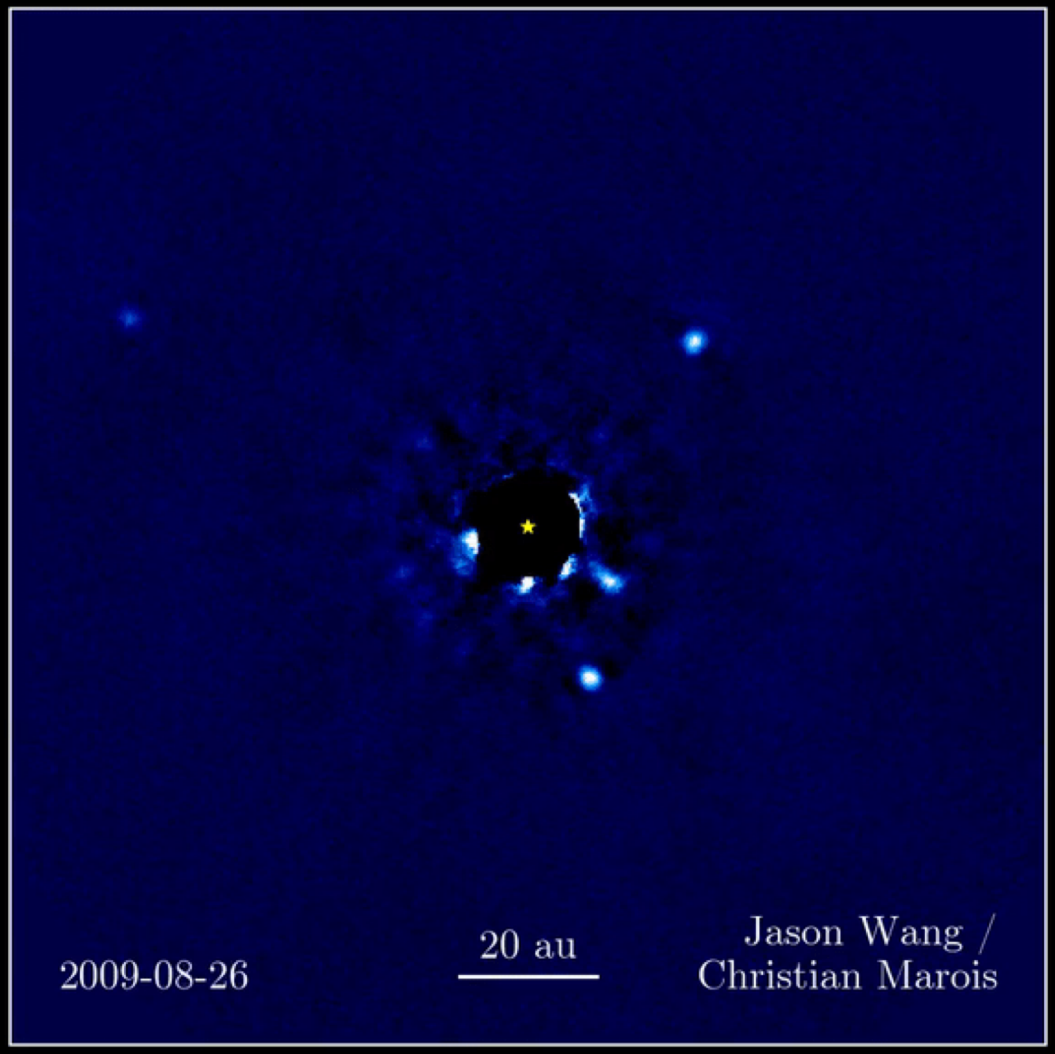
Jet Propulsion Laboratory, California Institute of Technology

December 14, 2018

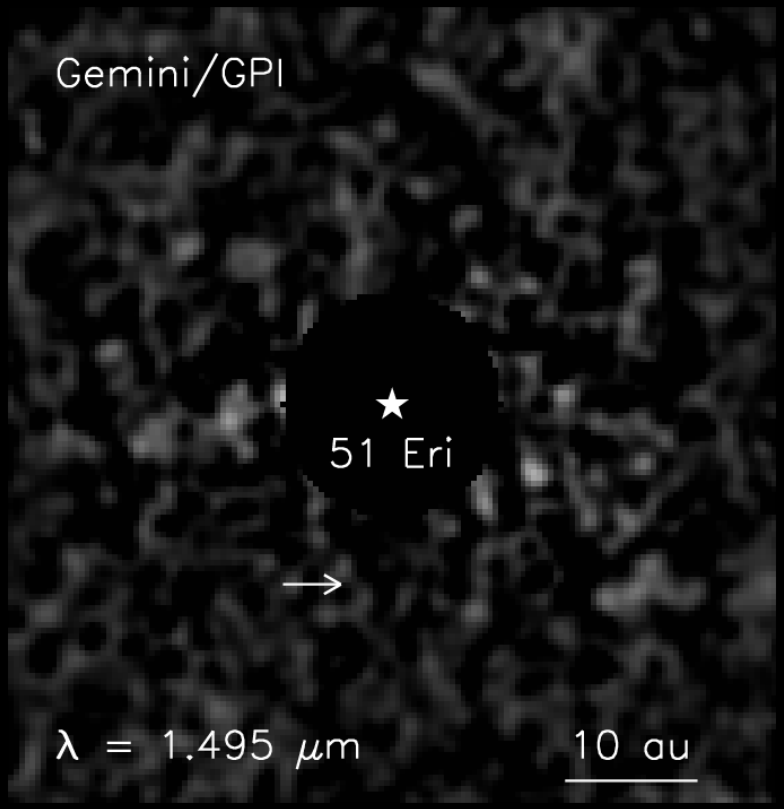
Exoplanets known today

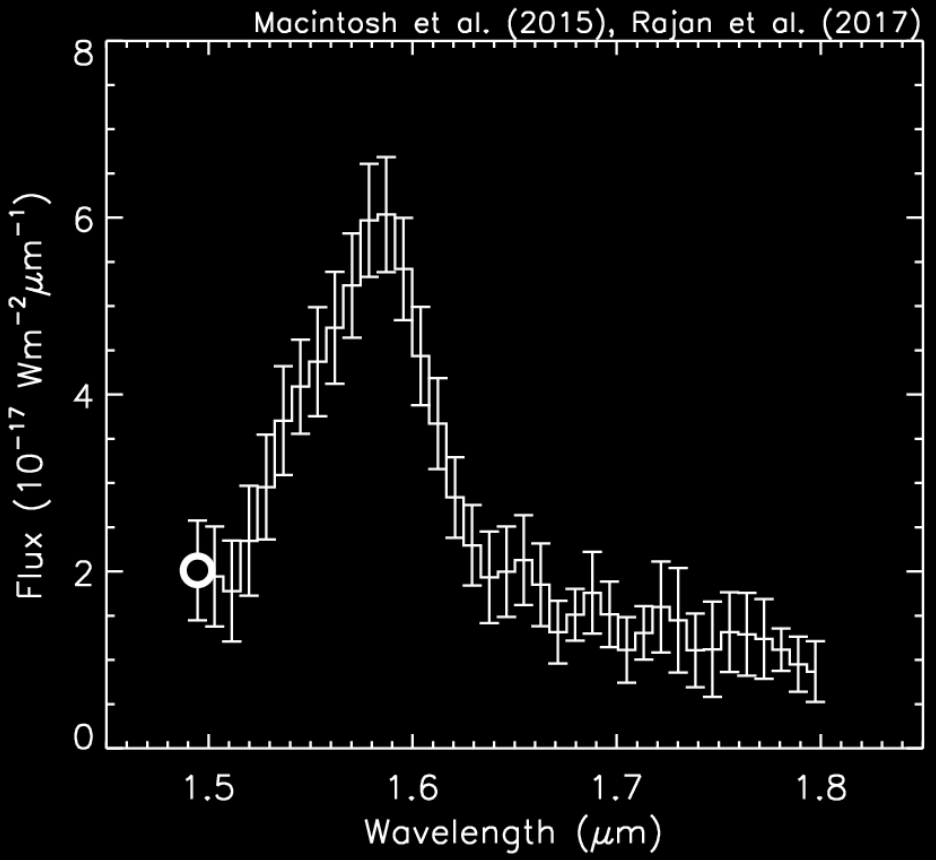


We just* take a picture!



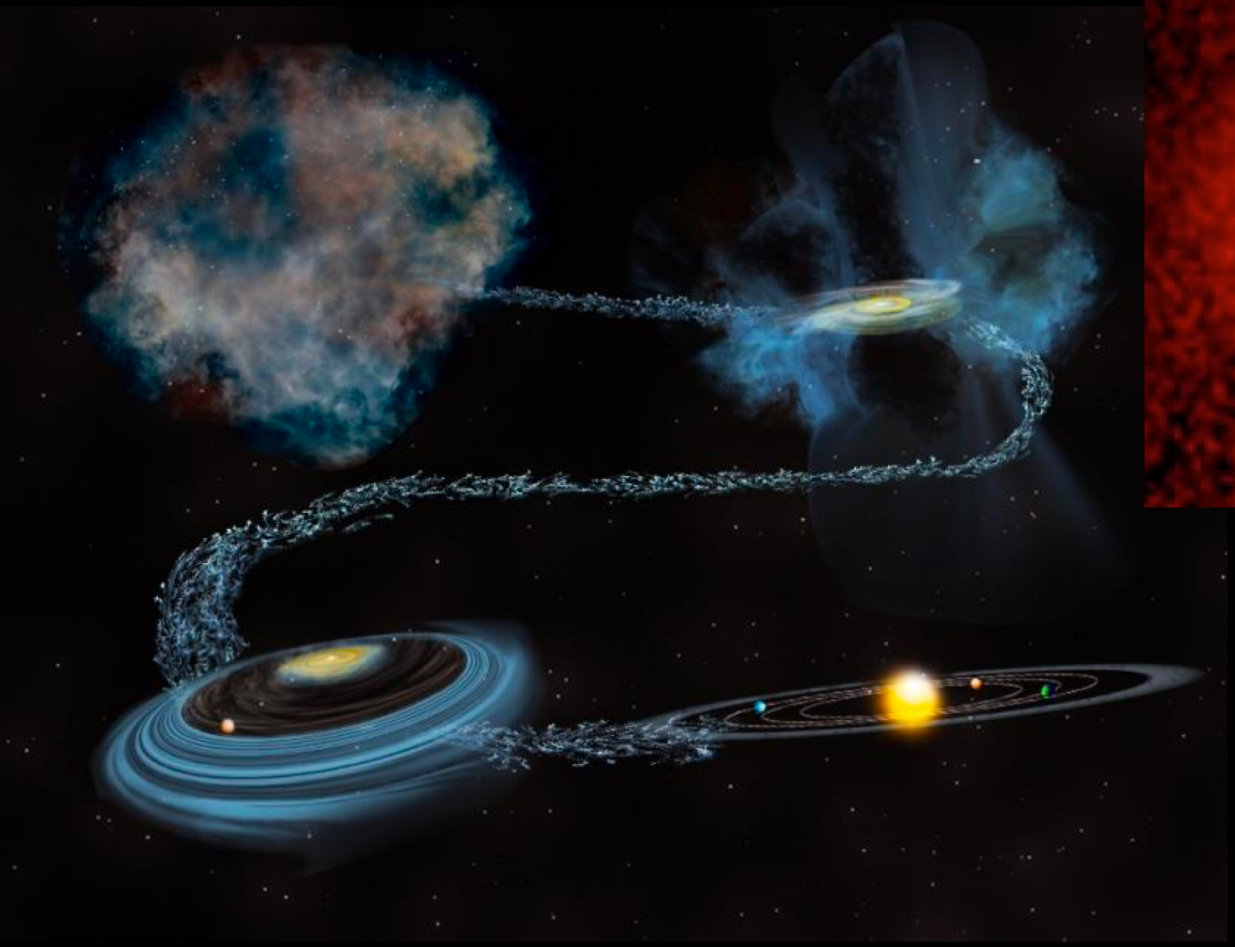
Spectra show molecular absorption signatures

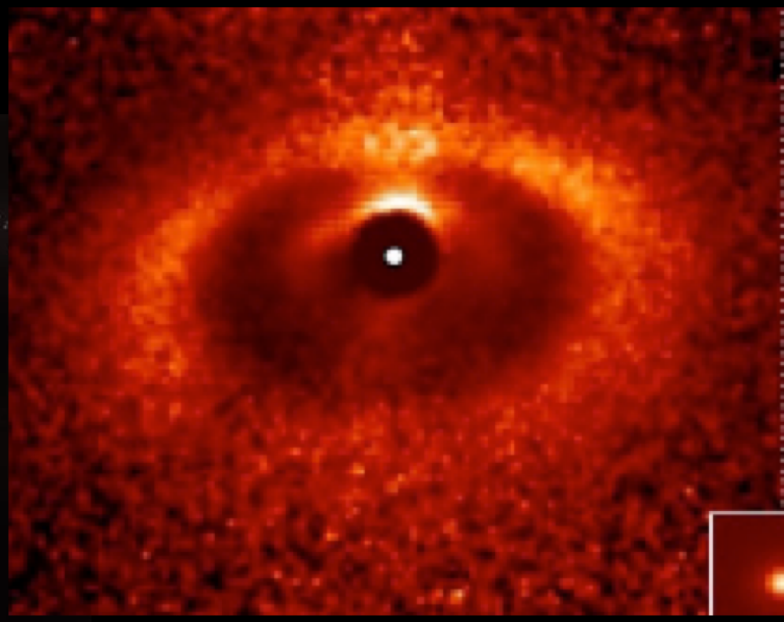


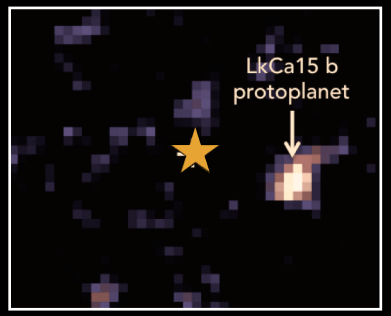


Credit: Rob De Rosa / GPIES

Catching planets in the act of formation

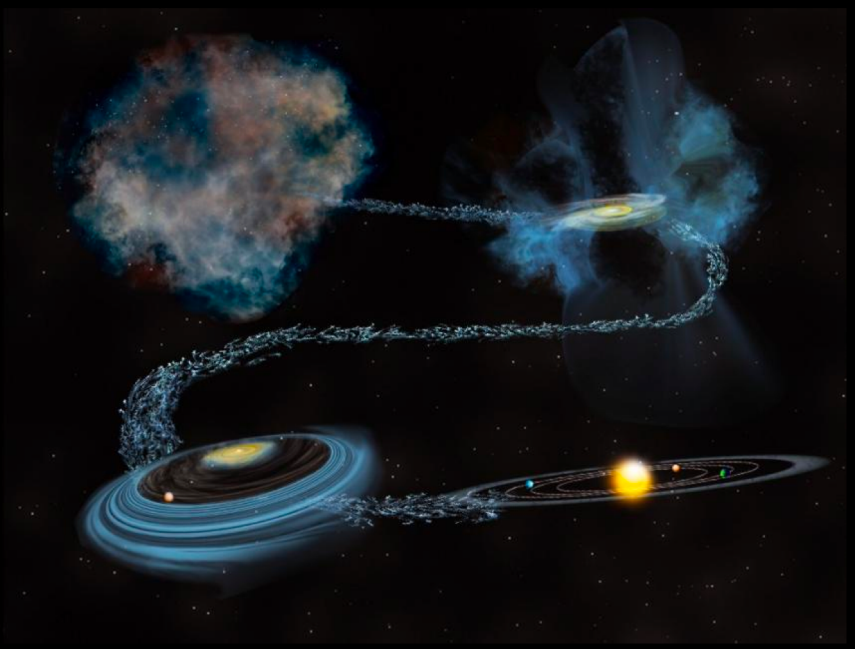




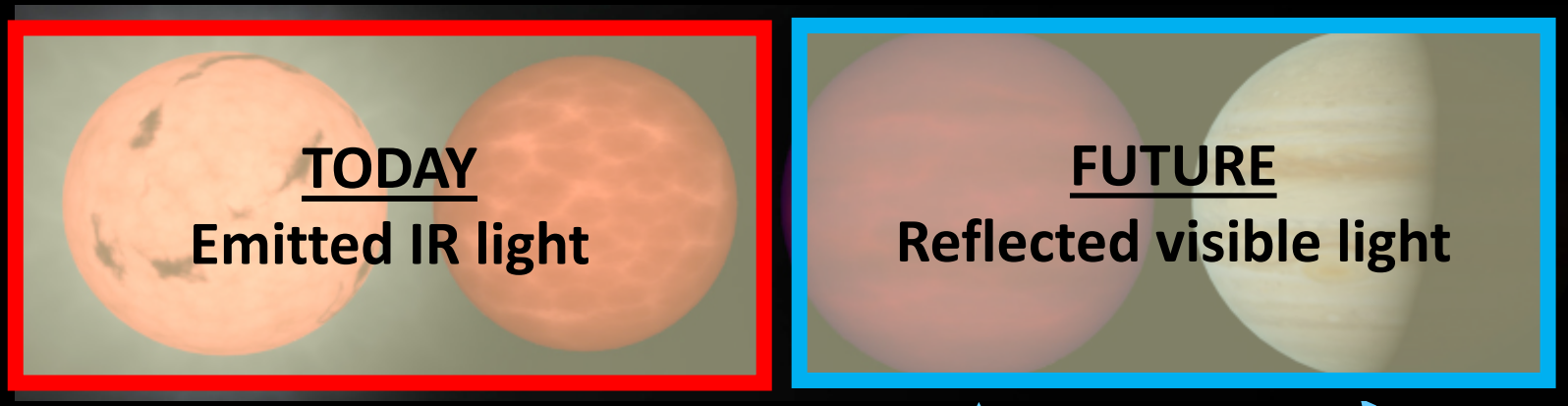


Thalmann+2016; Sallum, Follette,+2015

image credit: Bill Saxton, NSF/AUI/NRAO



Young planets are hot and glowing, but cool with time



Newly formed
1000-3000K

10 million yr
600K

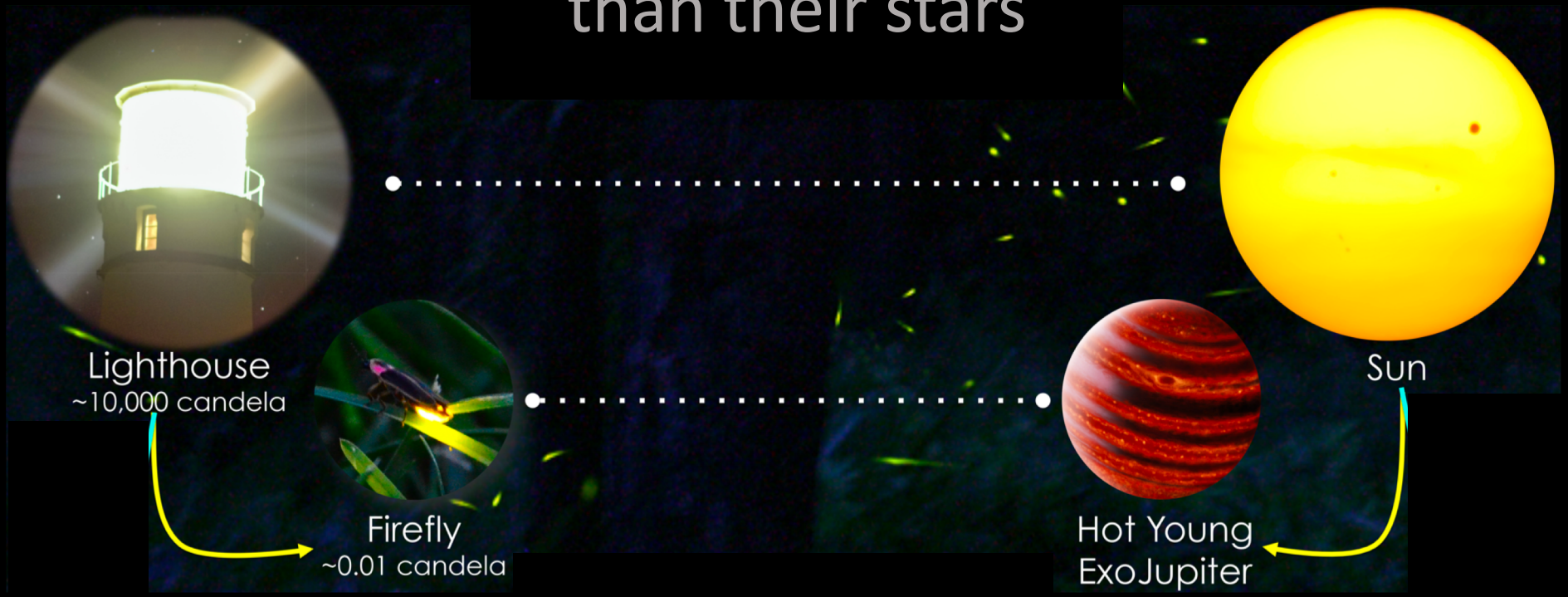
100 million yr
300K

4600 million yr
110K

Today: **Young super-Jupiters**

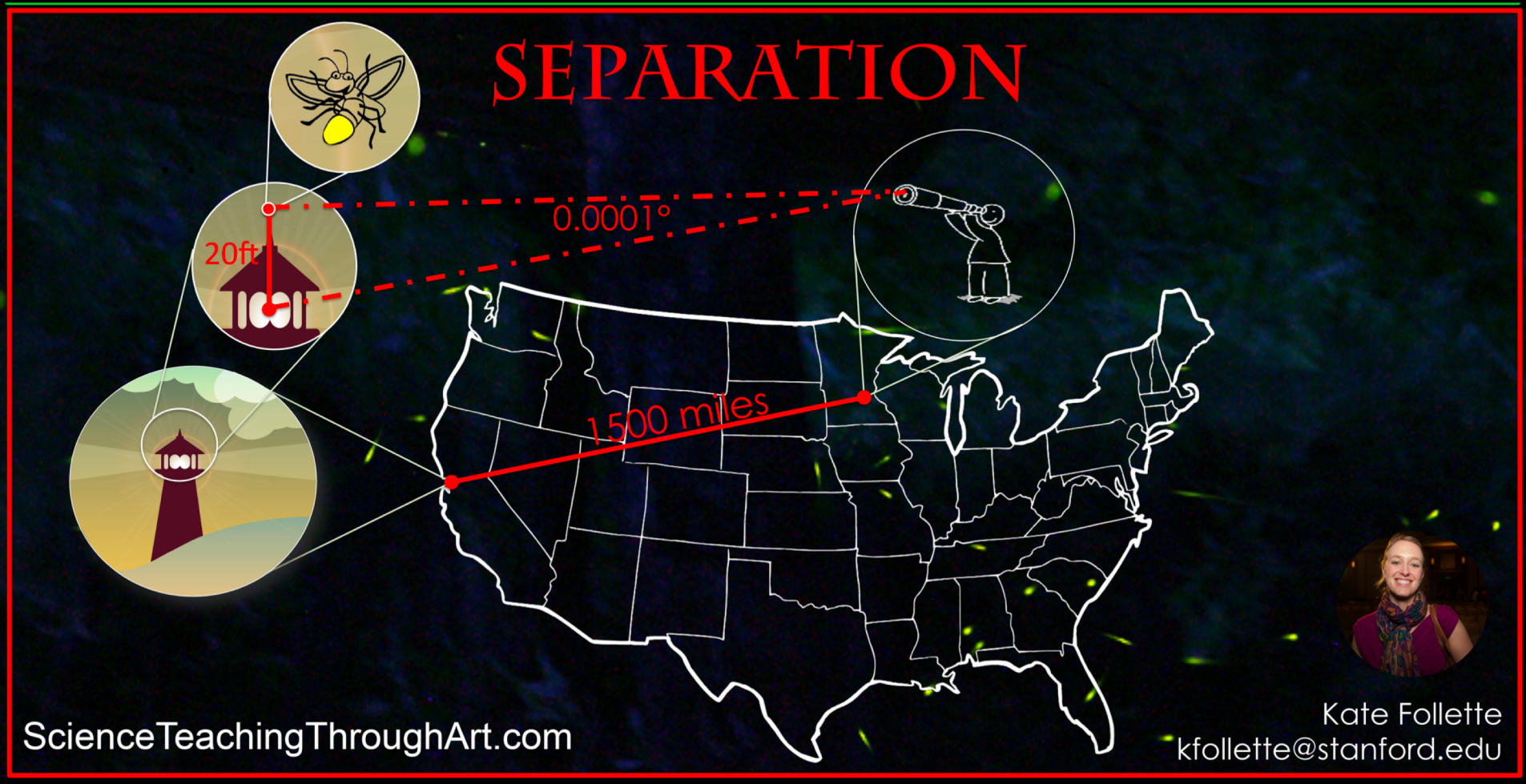
10^6 times fainter

than their stars



credit: Kate Follette

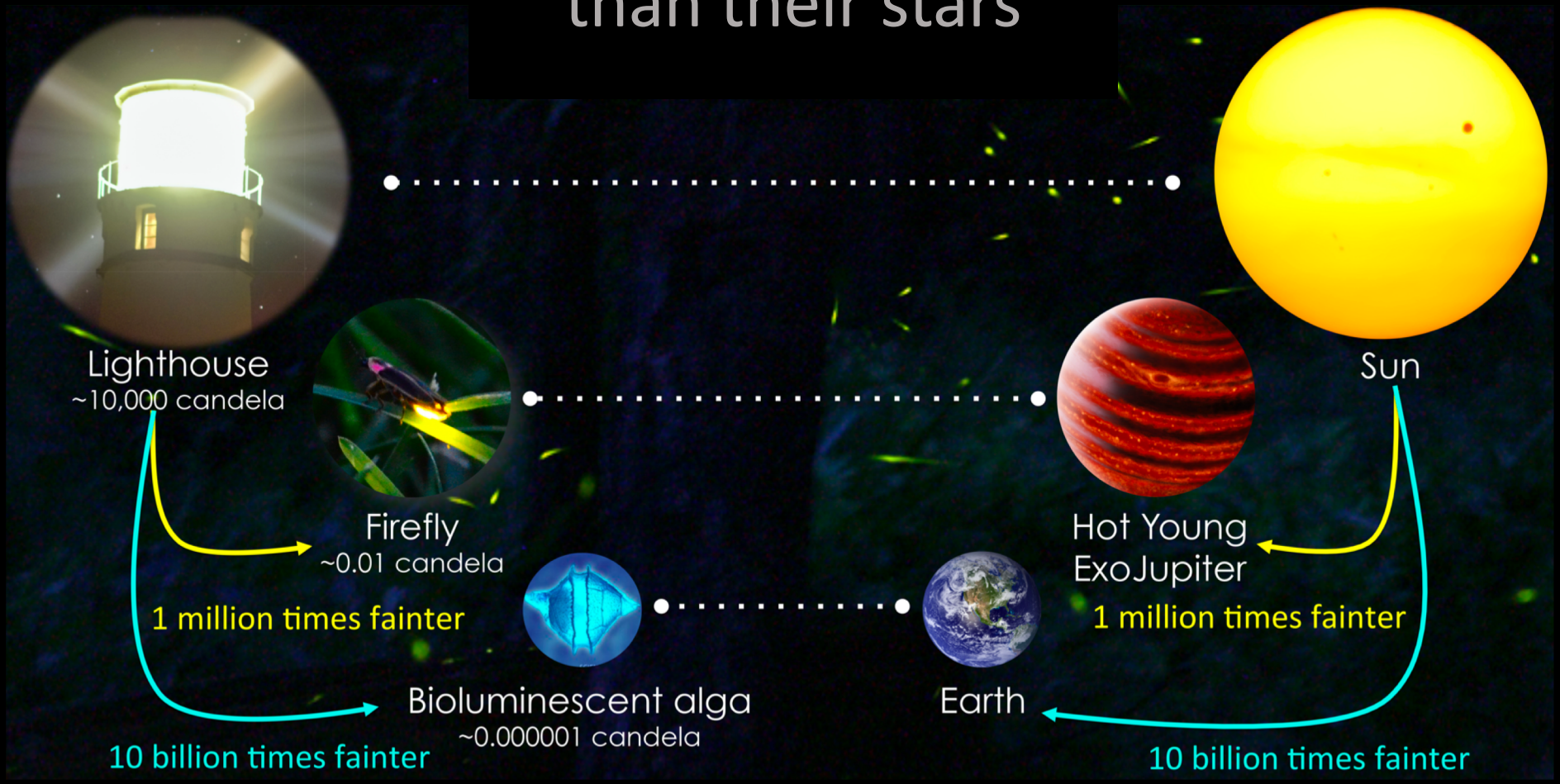
Planets appear < 0.5” from their stars



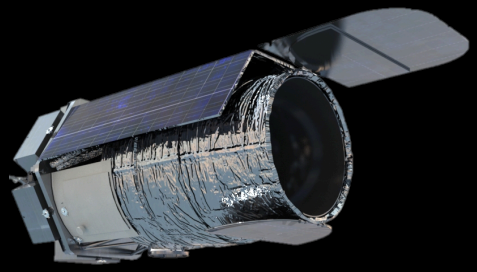
Goal: **Earth Twins**

$10x10^9$ times fainter

than their stars



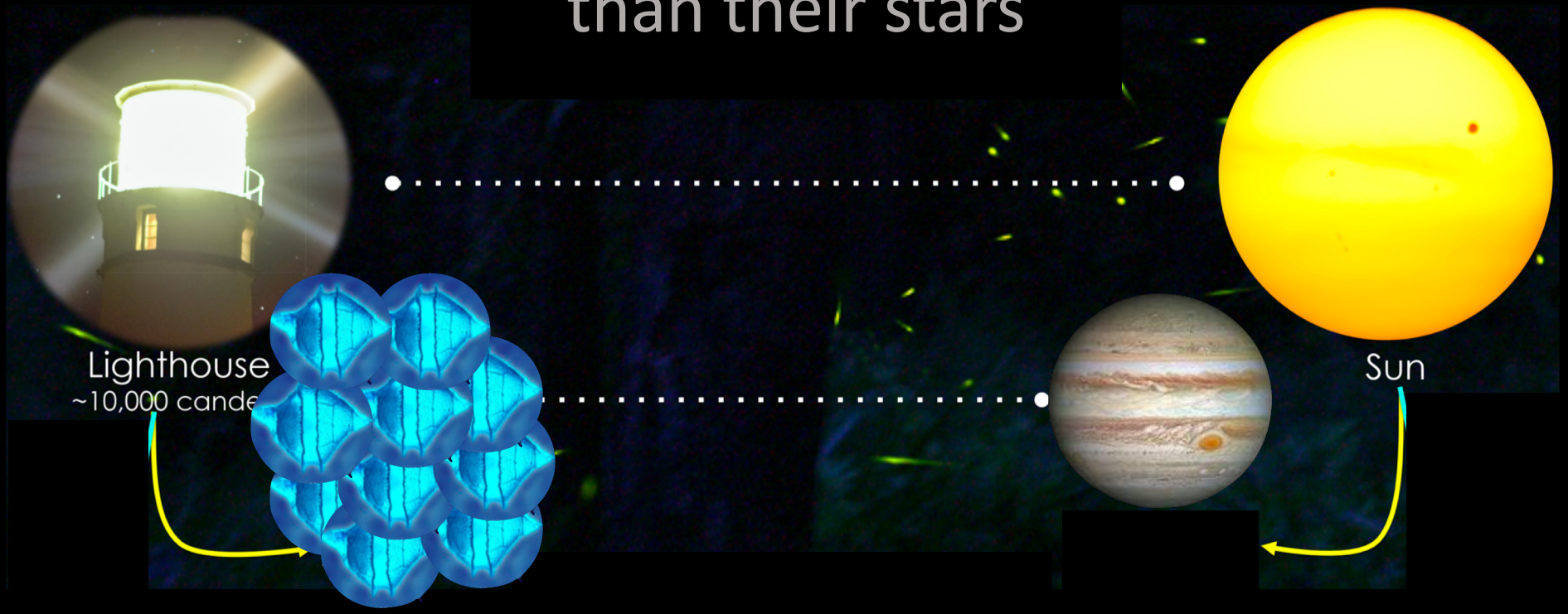
credit: Kate Follette



WFIRST CGI: **Jupiter twins**

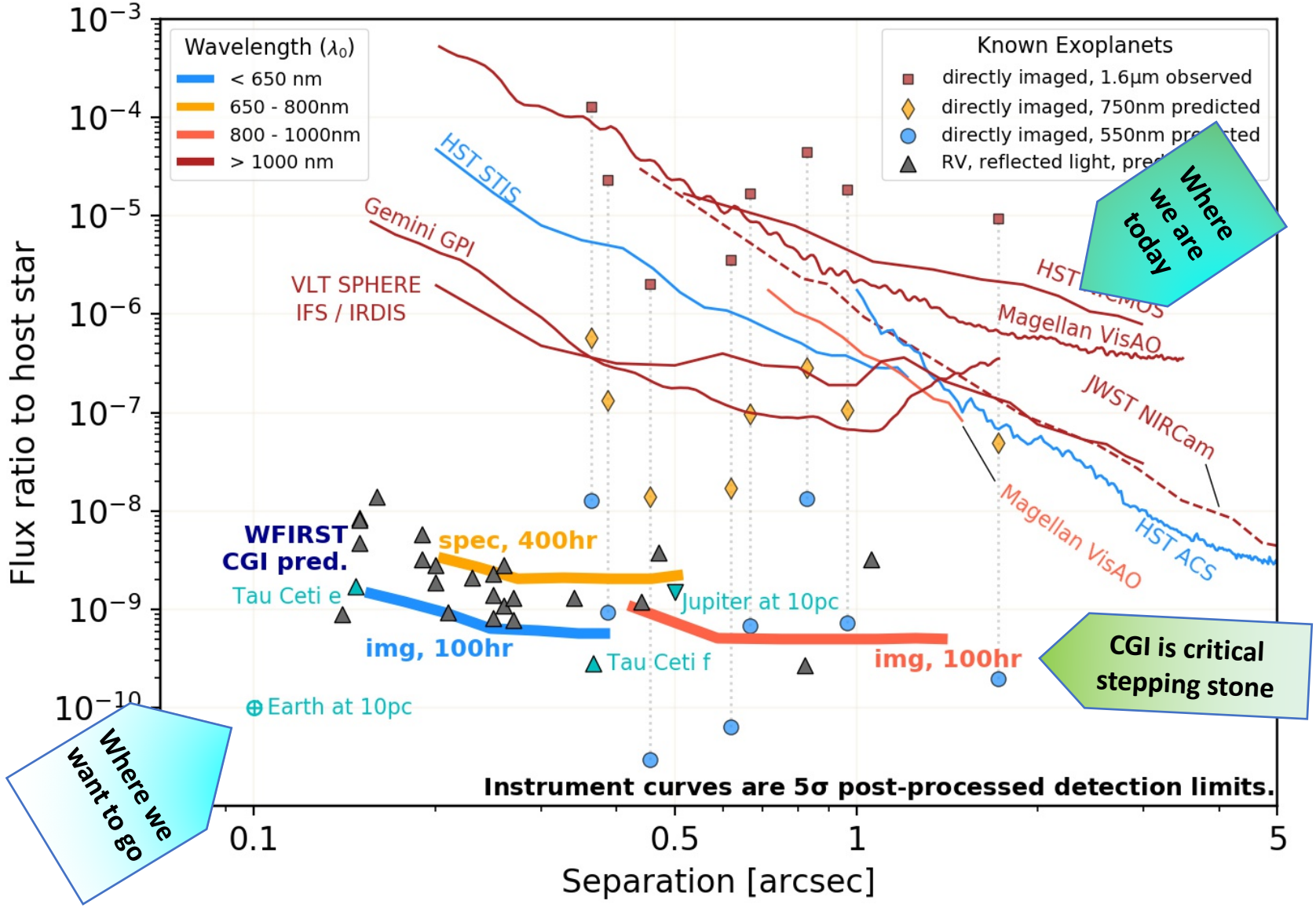
10^9 times fainter

than their stars

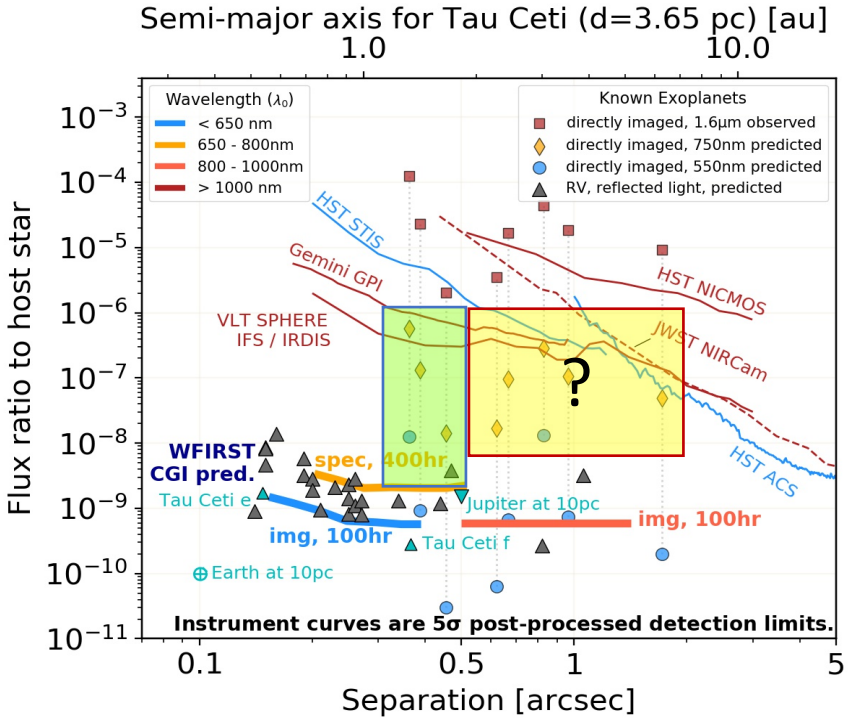


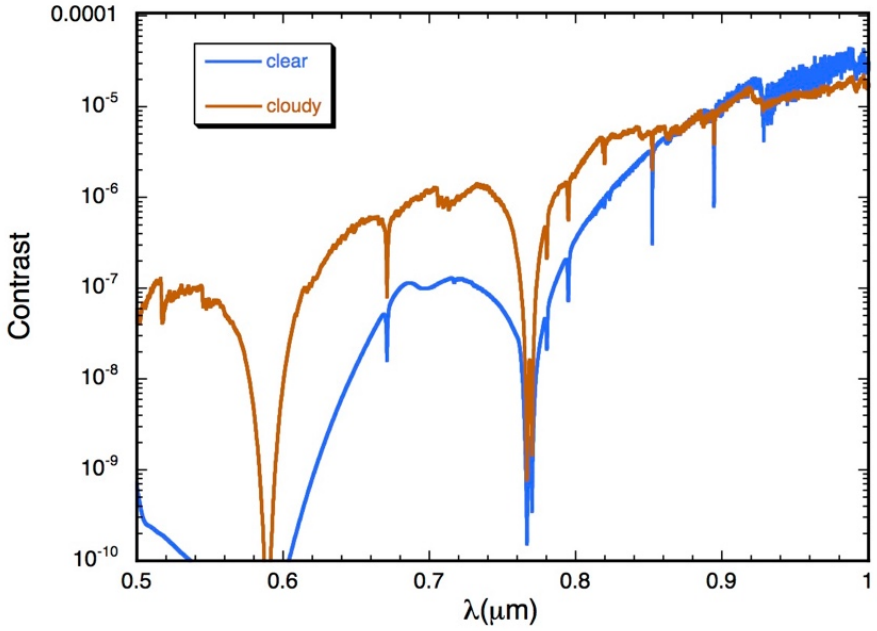
credit: Kate Follette; with modifications

CGI is a Pathfinder for Direct Imaging and Spectroscopy of Earth-like Exoplanets



Spectra of young self-luminous planets: HR 8799 e, 51 Eri b



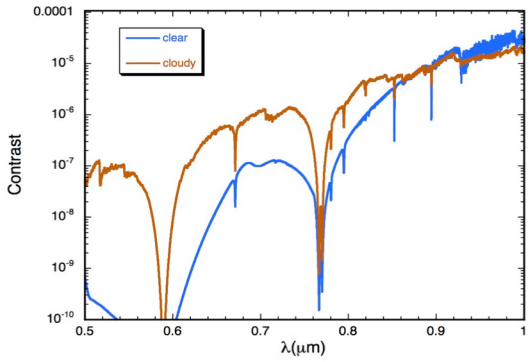


- CH4 abundance
- Cloud properties
- Halpha accretion?

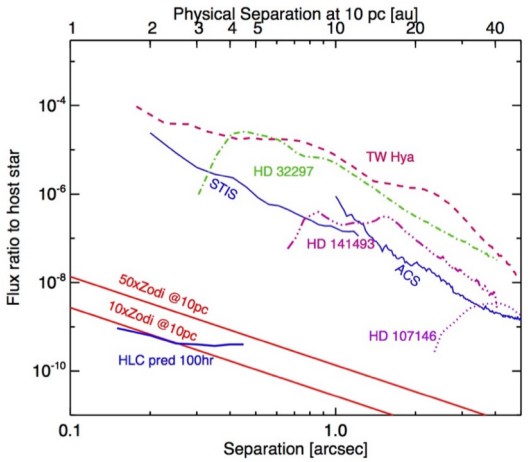
WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
ASTROPHYSICS • DARK ENERGY • EXOPLANETS

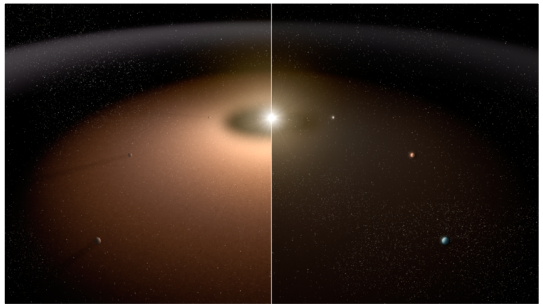
CGI potential science areas

Self-luminous, young super Jupiters: atm. properties

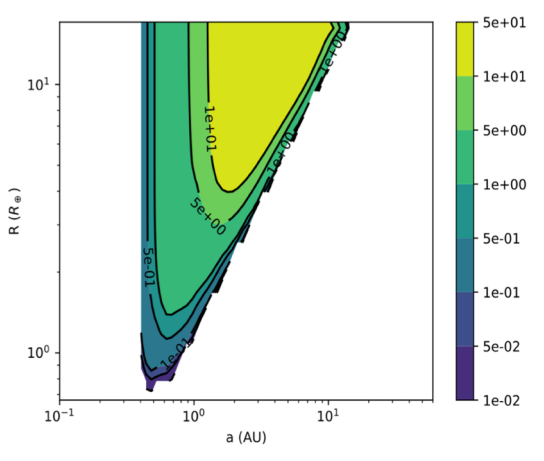


Circumstellar disks:
Protoplanetary (young)
Debris (mature)
Exozodi (mature, HZ)

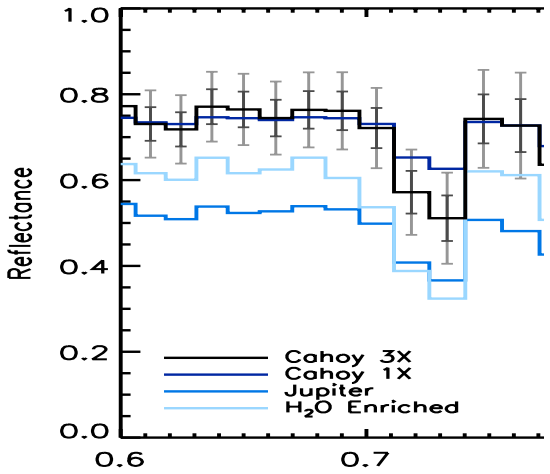




Possible blind searches for giant planets

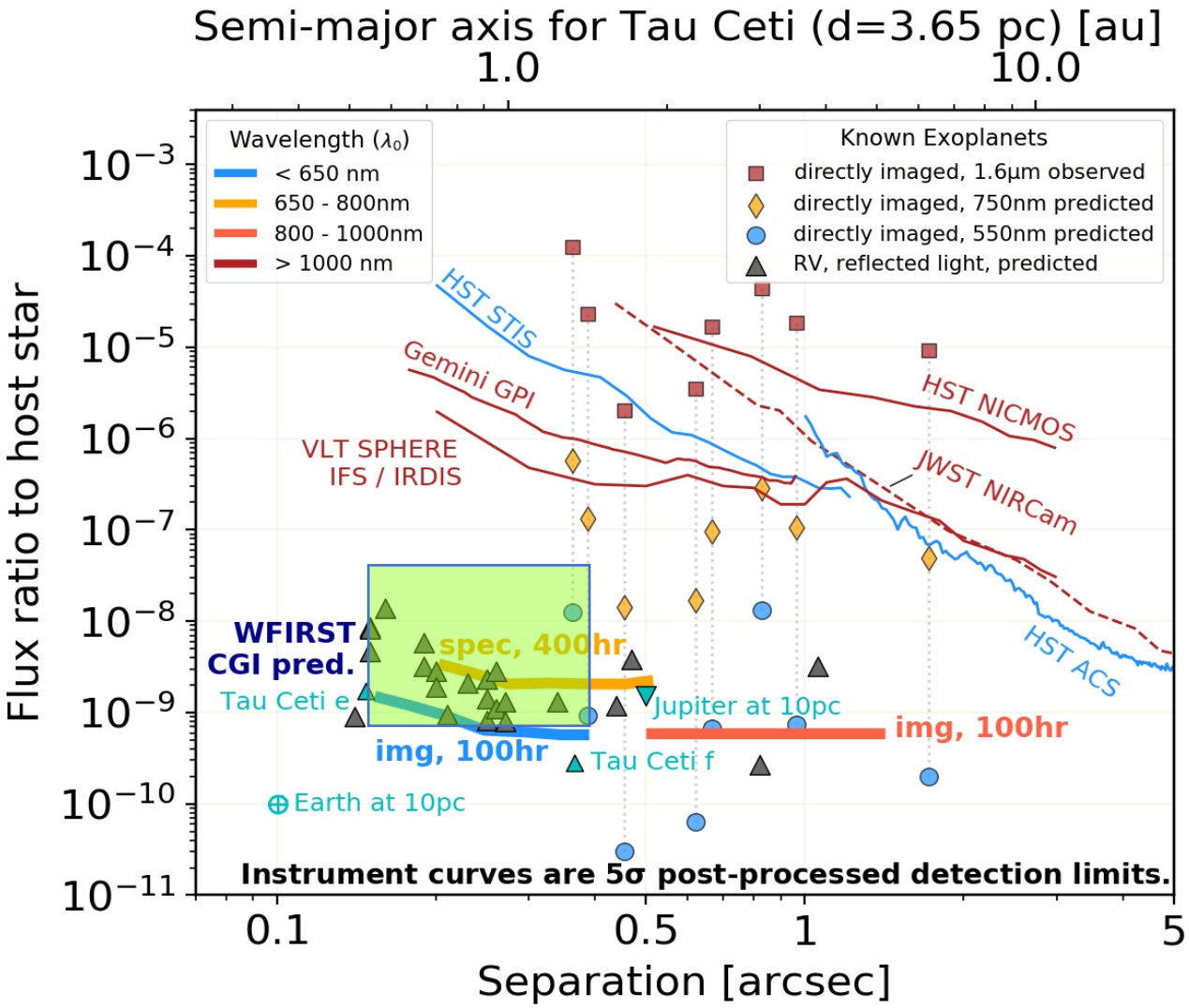


Mature Jupiter analogues in reflected light

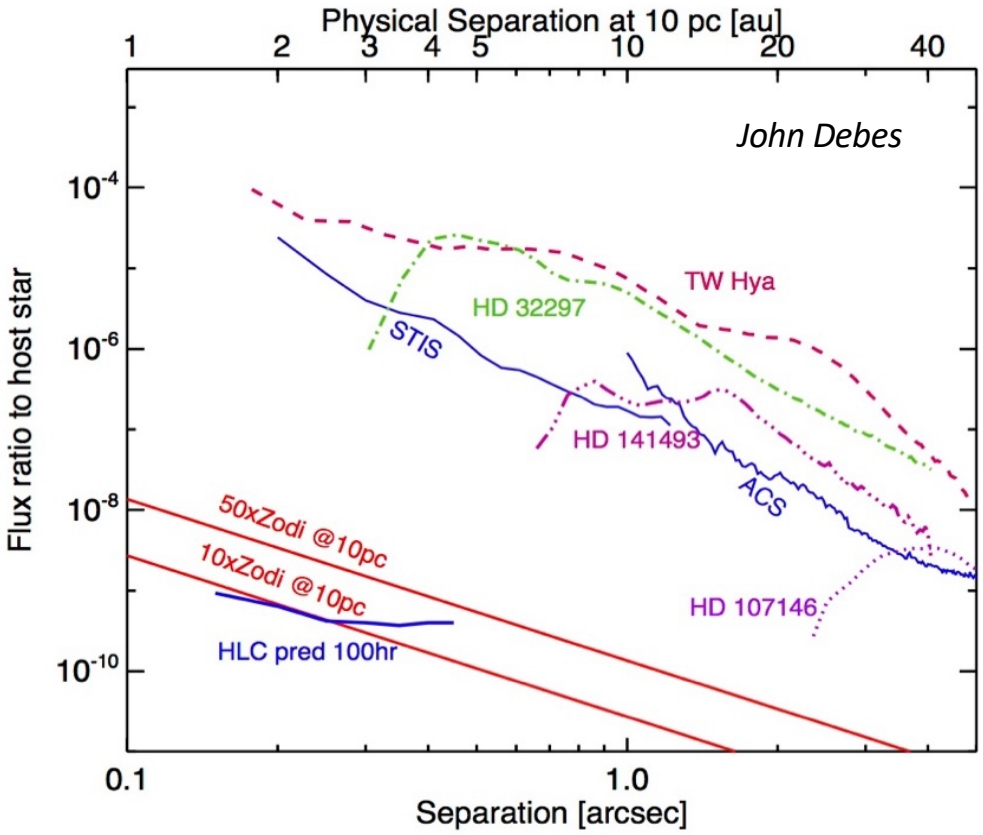


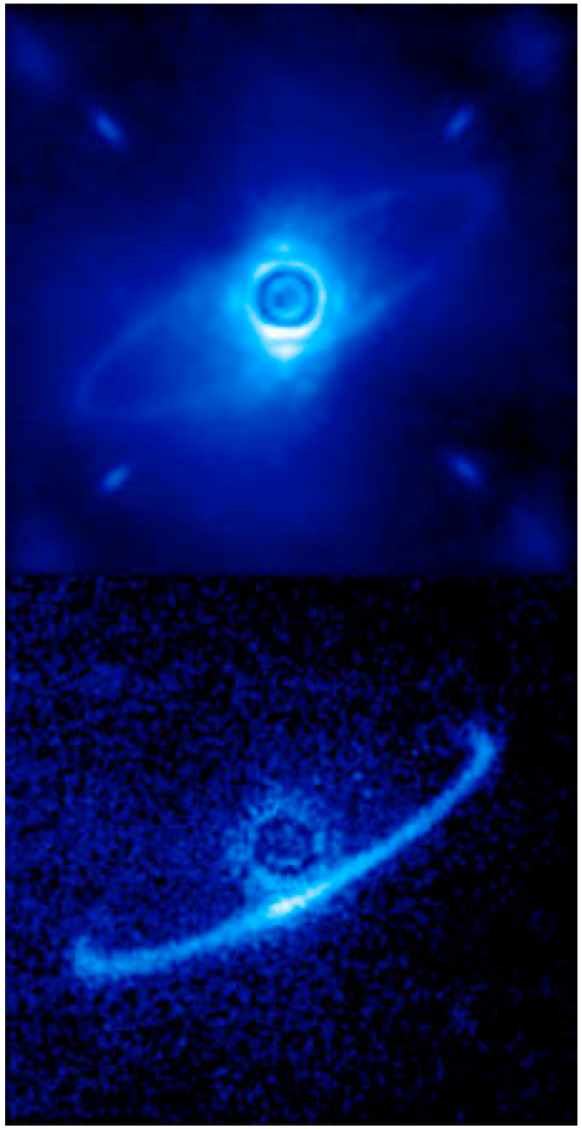
Possible characterization of Habitable Zone of nearby systems

Break vsin(i) mass degeneracy for RV planets with reflected light imaging

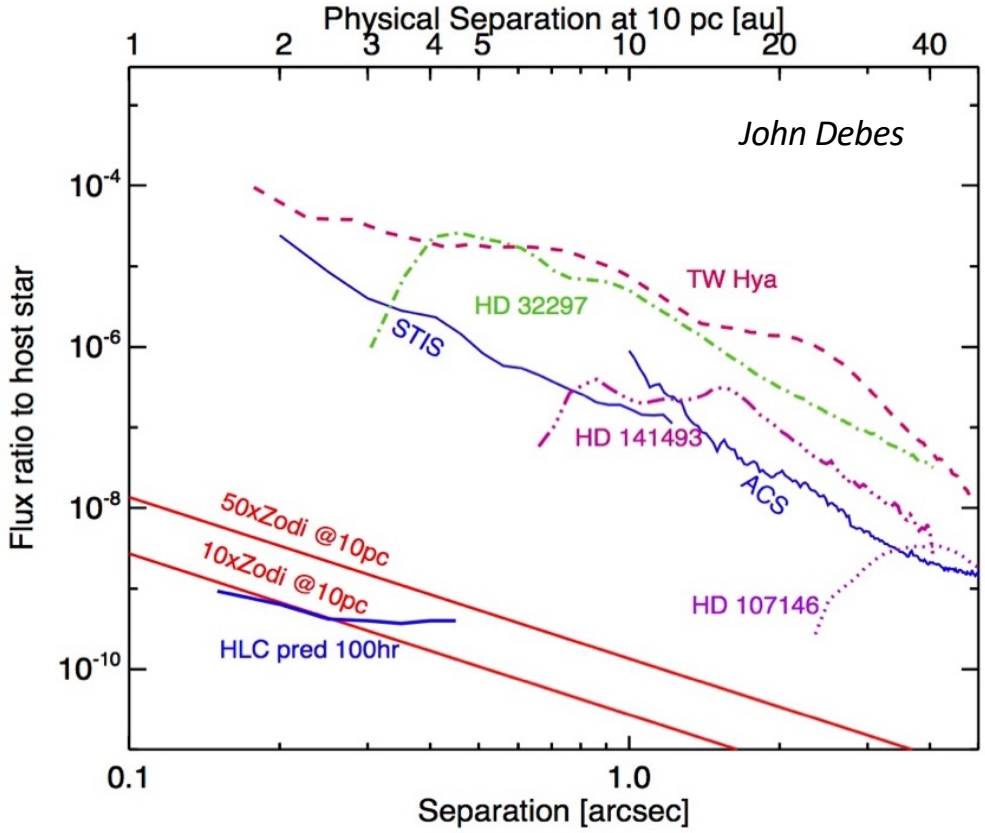


Imaging and Polarimetry of Debris Disks

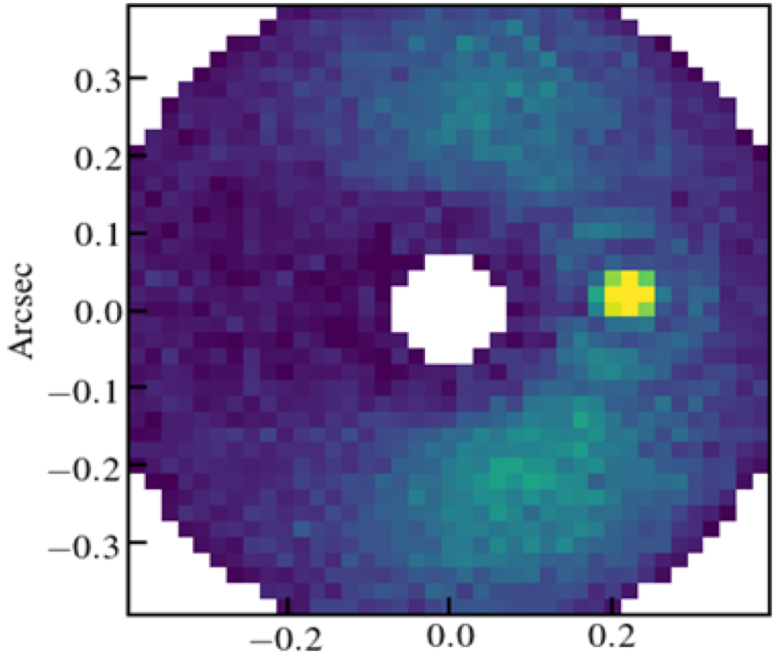




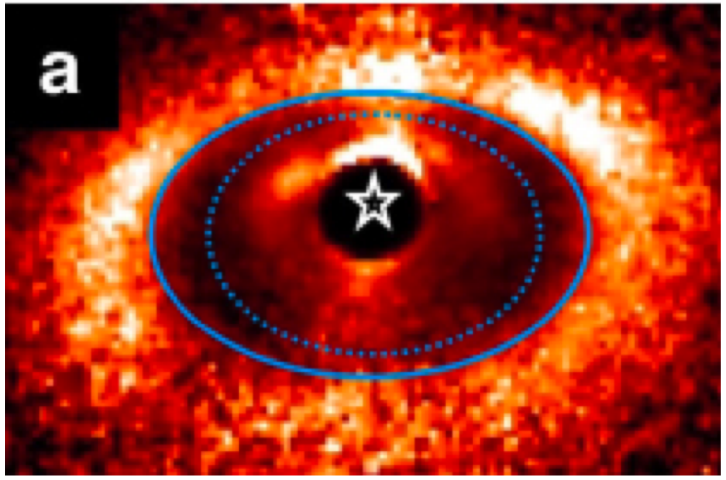
Exozodi : contaminants & targets



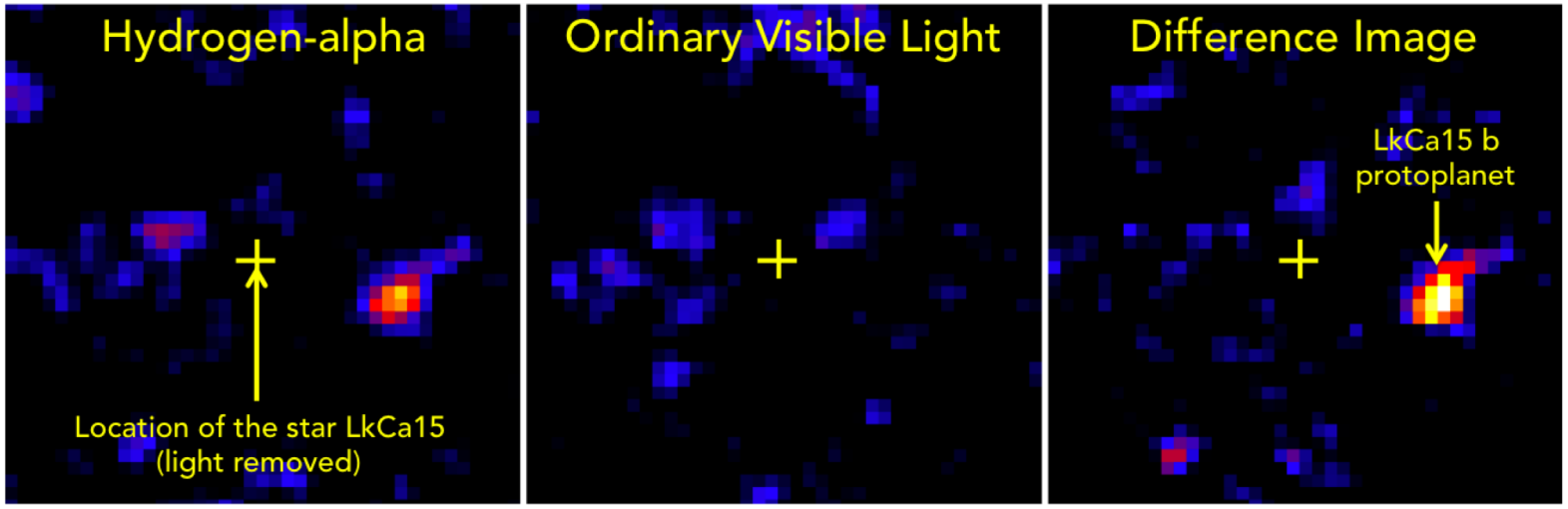
M. Rizzo, N. Zimmerman and the "Haystacks" team.
10zodi disk & embedded jovian planet located at 1.6 AU



Maybe: Protoplanetary disks & protoplanets



Thalmann et al. (2016)



Sallum et al. 2015

Summary

- CGI is a **technology demonstrator**
  - first “active” coronagraph in space
  - Important pathfinder for future missions to study exo-Earths

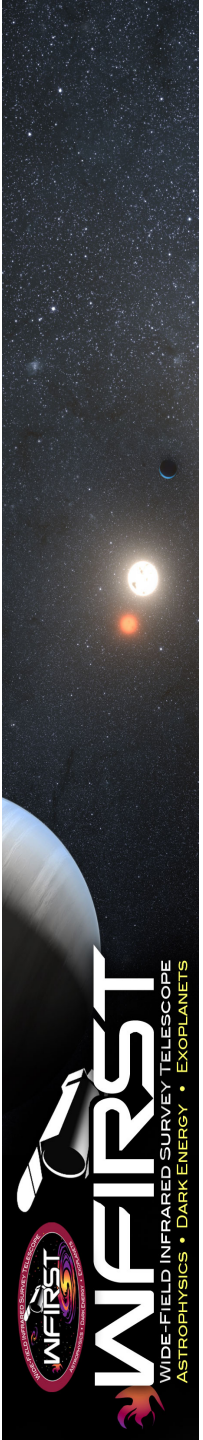
- CGI is capable of interesting science
  - Imaging & spectroscopy of young & mature planets
  - Imaging & polarimetry of debris disks, exozodi, & protoplanetary disks

WFIRST

Wide-Field Infrared Survey Telescope

Astrophysics • Dark Energy • Exoplanets

backup

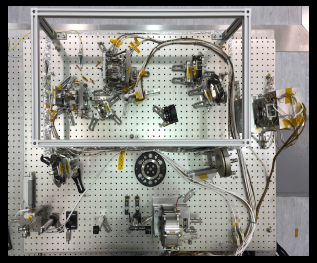


The Coronagraph Instrument (**CGI**) is a technology pathfinder for future imaging and spectroscopy of Earth-like planets

WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
ASTROPHYSICS • DARK ENERGY • EXOPLANETS

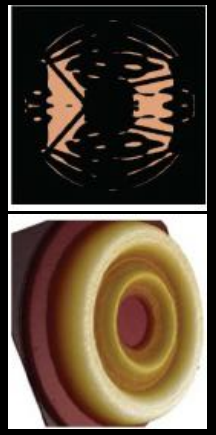
CGI will demonstrate key technologies for future missions

Autonomous Ultra-Precise Wavefront Sensing & Control

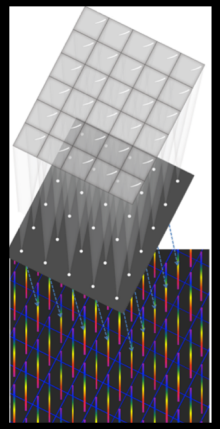


Large-format Deformable Mirrors

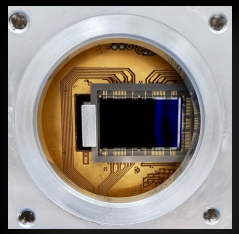
High-contrast Coronagraph Masks



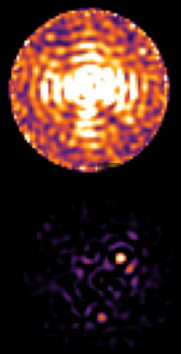
High-contrast Integral Field Spectroscopy



Ultra-low noise photon counting Visible Detectors

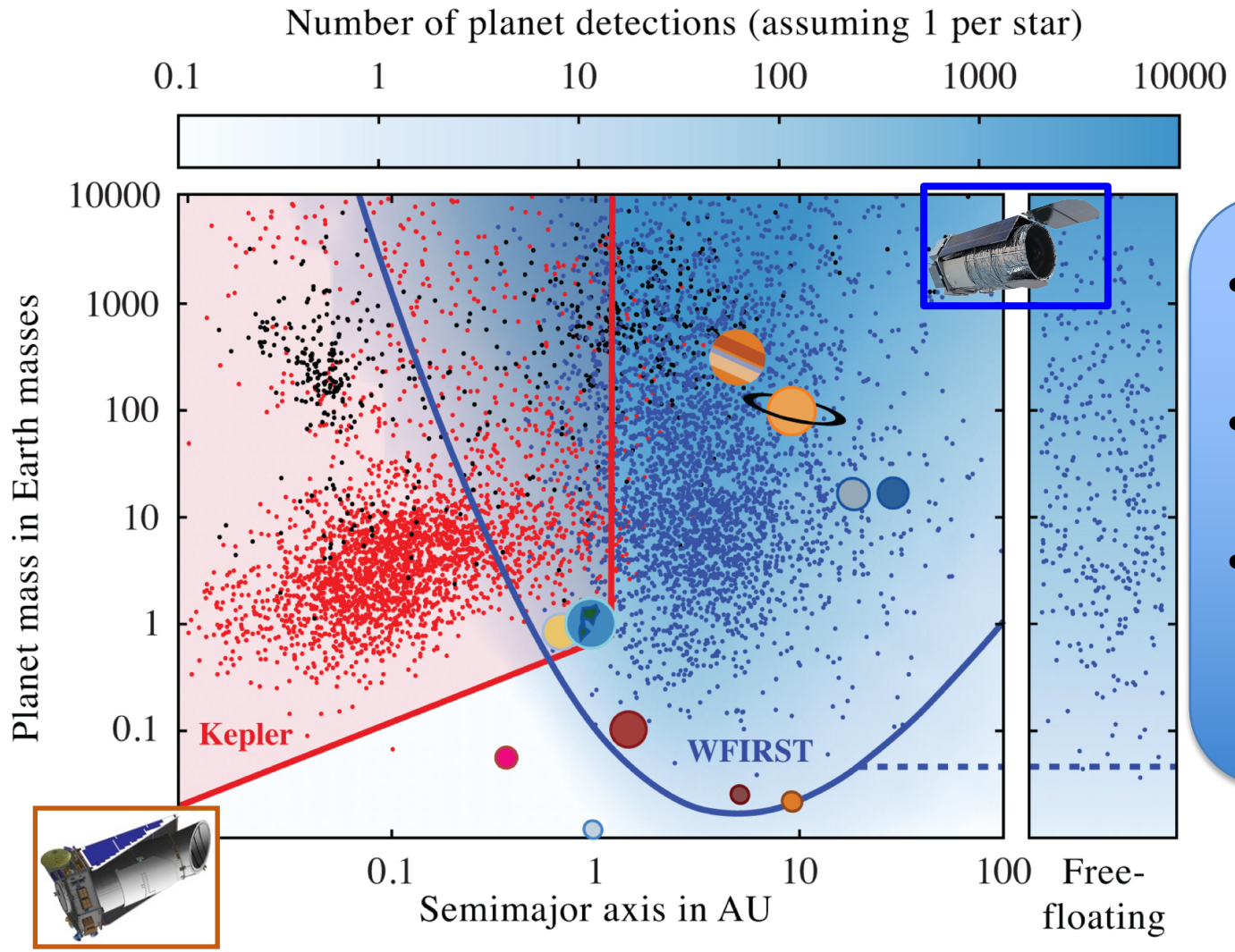


Data Post-Processing



CGI is a “technology demonstration” instrument

WFI microlensing
complements Kepler, TESS, PLATO



- 2600 planet detections.
- **370 with < 1 Earth mass**
- Hundreds of free-floating planets.